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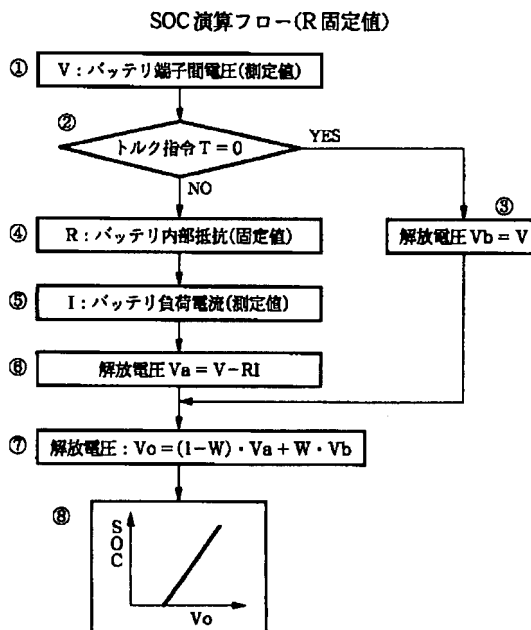
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(54)【発明の名称】 バッテリ残存容量推定装置

(57)【要約】

【課題】 バッテリ解放電圧の演算誤差をなくしバッテリ残存容量(SOC)を正確に推定する。

【解決手段】 ①でバッテリ端子間電圧Vを測定し、②でバッテリ負荷の有無を負荷(モータ)のトルク指令から判断し、③で負荷運転時の解放電圧Vb=Vを求め、⑤でバッテリの負荷運転時における解放電圧Vaを、バッテリの内部抵抗R、端子間電圧V、負荷電流Iから $Va = V - RI$ として求め、⑦でVa、Vbに重みWをつけて、バッテリ解放電圧 $Vo = (1 - W) \cdot Va + W \cdot Vb$ を計算し、⑧でVoからSOCを計算して推定する。このSOC推定では、バッテリ解放電圧Voを、電圧精度として不十分な負荷運転時の推定解放電圧Vaに対し、電圧精度が高い無負荷時の解放電圧Vbを重み付けして演算処理にてバッテリの解放電圧Voを算出しているので、Vo推定精度が上り、SOC推定精度が向上する。



【特許請求の範囲】

【請求項1】 バッテリ端子間電圧とバッテリ負荷電流及びバッテリ内部抵抗からバッテリ解放電圧を推定し、この推定バッテリ解放電圧からバッテリの残存容量を推定するバッテリ残存容量推定装置において、前記推定バッテリ解放電圧を、バッテリの無負荷運転時の解放電圧とバッテリの負荷運転時における端子電圧からバッテリ内部抵抗降下分を差し引いた負荷運転時の推定解放電圧に重みをつけて算出することを特徴とするバッテリ残存容量推定装置。

【請求項2】 請求項1において、バッテリ残存容量—内部抵抗特性マップを設け、前記バッテリ内部抵抗を、バッテリ残存容量—内部抵抗の特性マップを利用し、バッテリ残存容量の前回値より演算処理にて推定することを特徴とするバッテリ残存容量推定装置。

【請求項3】 請求項1において、前記バッテリ内部抵抗を、バッテリ解放電圧が変化しないと仮定できる短時間の間における異なるバッテリ端子間電圧及びバッテリ負荷電流より演算処理にて推定することを特徴とするバッテリ残存容量推定装置。

【請求項4】 請求項1又は3においてバッテリ負荷がインバータモータの場合モータ効率とインバータ効率を含んだインバータモータの総合効率マップを設け、前記バッテリ負荷電流を、バッテリの負荷であるインバータモータの現時点の回転数とトルク指令からモータ出力を求め、このモータ出力と前記インバータモータの総合効率マップから導かれる効率によってバッテリ出力電力を求め、このバッテリ出力電力とバッテリ端子間電圧からバッテリ負荷電流を算出することを特徴とするバッテリ残存容量推定装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は、電気自動車やハイブリッド電気自動車等のバッテリをエネルギー源としてモータを駆動するシステムにおける、バッテリの残存容量を推定するバッテリ残存容量推定装置に関する。

【0002】

【従来の技術】一般に、バッテリの残存容量(SOC)は、バッテリの解放電圧と密接な関係を持っており、解放電圧からSOCを推定することが可能である。

【0003】負荷時にバッテリの解放電圧は直接推定できないが、バッテリ端子間電圧とバッテリ内部抵抗(固定値)とバッテリ負荷電流(放電電流又は充電電流)によって算出でき、この値よりSOCが推定可能である。このSOC推定の演算フローを図5に示す。

【0004】通電中の電圧、電流の推定データから解放電圧を推定し、SOCを推定する装置の一例を図6に示す。この装置は、バッテリPBの負荷電流を検出しA/D変換した実測電流データI_jから第一演算回路14で

バッテリ端子間電圧V_j'を推定し、バッテリ電圧を検出しA/D変換した実測端子間電圧データV_jと上記推定端子間電圧V_j'との差e_jを比較回路15で演算し、第1演算回路14で前記差e_jに基づき推定端子間電圧V_j'を実測端子間電圧に近似させるべく前記差e_jをフィードバックさせながら第1演算回路14における第1関係式の関数項の変更と演算をe_j=0となるまで繰り返す、定数分C_jを推定解放電圧として出力し、第二演算回路21で推定解放電圧に基づいてSOCを演算している。(特開平5-142314)

【0005】

【発明が解決しようとする課題】ところで、バッテリ内部抵抗RはSOCの値に関連して逐次変化するため正確なSOCを推定することは困難である。また、バッテリから負荷電流(放電電流、充電電流)を推定するため、ホールCTなどの電流検出装置を取り付ける必要があり、コスト高になる。

【0006】この発明は、上記課題を解決すべくなされたものであり、その目的とするところは、前回SOCの値に基づいたバッテリ内部抵抗を求め無負荷運転時と負荷運転時の推定解放電圧に重みをつけて精度を上げた、開放電圧からSOCを正確に推定しうるようにしたバッテリ残存容量推定装置を提供することにある。

【0007】

【課題を解決するための手段】この発明は、バッテリ端子間電圧とバッテリ負荷電流及びバッテリ内部抵抗からバッテリ解放電圧を推定し、この推定バッテリ解放電圧からバッテリの残存容量を推定するバッテリ残存容量推定装置において、前記推定バッテリ解放電圧を、バッテリの無負荷運転時の解放電圧とバッテリの負荷運転時における端子電圧からバッテリ内部抵抗降下分を差し引いた負荷運転時の推定解放電圧に重みをつけて算出することを特徴とする。

【0008】前記バッテリ内部抵抗は、バッテリ残存容量—内部抵抗の特性マップ設け、この特性マップを利用しバッテリ残存容量の前回値より演算により推定、または、バッテリ解放電圧が変化しないと仮定できる短時間の前後時点におけるバッテリ端子間電圧及びバッテリ負荷電流を用いて計算より推定するとよい。

【0009】また、バッテリ負荷がインバータモータの場合、モータ効率とインバータ効率を含んだインバータモータの総合効率マップを設け、前記バッテリ負荷電流は、バッテリの負荷であるインバータモータの現時点の回転数とトルク指令からモータ出力を求め、このモータ出力と前記インバータモータの総合効率マップから導かれる効率によってバッテリ出力電力を求め、このバッテリ出力電力とバッテリ端子間電圧からバッテリ負荷電流を計算により推定するとよい。

【0010】

【発明の実施の形態】実施の形態1

電気自動車やハイブリット電気自動車は通常走行時にモータのトルク指令をゼロにする場合が多々ある。トルク指令がゼロの時はバッテリー電流がゼロとなるためバッテリー解放電圧は端子電圧と等しくなり正確なバッテリー残容量(SOC)が推定できる。

【0011】実施の形態1は図1に示すように従来図5に示したSOC推定の計算フローに、トルク指令値がゼロの場合の条件を付加し、更に重み付けを行ないSOCを推定する。SOC推定装置は、バッテリー端子間電圧及びバッテリー負荷電流を検出する電圧、電流検出器と、検出した電圧、電流信号をデジタル信号に変換するA/D変換器と、この電圧、電流データを用いてSOC推定をするCPU等からなる演算部で構成されている(図示省略)。

【0012】図1について、上記SOC推定装置演算部におけるSOC推定の演算処理手順を説明する。

【0013】まず、ステップ①でCPUはA/D変換器を介してバッテリー端子間電圧Vを測定し、②でバッテリーで駆動されるモータのトルク指令Tがゼロであるか否かを判断する。この判断結果がYES(T=0)の場合は、③で解放電圧Vbにバッテリー端子間電圧Vを代入する。NO(T≠0)の場合は、④、⑤でバッテリー内部抵抗R(固定値)とバッテリー負荷電流Iを取り込み、⑥で解放電圧 $V_a = V - RI$ を算出する。

【0014】⑦で解放電圧 V_a 、 V_b に重み付けをして解放電圧 $V_o = (1-W) \cdot V_a + W \cdot V_b$ を算出する。重みW付けにより計算による負荷運転時の解放電圧 V_a を重視するか、無負荷運転時の解放電圧 V_b を重視するかを任意に設定できる。(W=0の時: $V_o = V_a$ 、W=1の時: $V_o = V_b$)。そして⑧で解放電圧 V_o よりSOCを計算してSOCを推定する。

【0015】上記実施の形態1によれば、上記従来図5のSOC推定方式にトルク指令Tがゼロの場合の条件を付加し、負荷時と無負荷時の解放電圧に重み付けを行なってSOCを推定しているため、SOC推定の精度が向上する。

*【0016】実施の形態2

バッテリー内部抵抗Rは放電時と充電時各々についてバッテリーの残容量(SOC)の関数になっていることがわかっている。

【0017】実施の形態2は図2に示すように、上記図1の⑥の解放電圧 V_a の計算に使用する④のバッテリー内部抵抗R(固定値)を推定値に代えてとして図1の場合と同様にSOCを推定する。

【0018】上記図2④のバッテリー内部抵抗R推定の演算処理手順を図3について説明する。予めバッテリーの充電時と放電時それぞれについてSOCに対する内部抵抗RのマップA、Bを用意し、図2の②におけるトルク指令が0か否かの判断結果がNOの場合、ステップ41でトルク指令Tがゼロより大きいかな否かの判断をする。この判断結果がYES(放電時)の場合、42でマップAにより前回推定のSOC値からバッテリー内部抵抗Rを推定し、NO(充電時)の場合、43でマップBにより前回推定のSOC値からバッテリー内部抵抗Rを推定する。

【0019】上記実施の形態2によれば、バッテリー内部抵抗Rを推定して解放電圧 V_a を計算しているため、SOCの推定精度が上記図1の場合より向上する。

【0020】実施の形態3

実施の形態3では実施の形態2と同様に図2のSOC推定の計算フローでSOCを推定するが、④のバッテリー内部抵抗Rの推定はバッテリーの端子間電圧Vと負荷電流Iを用いて計算により推定する。

【0021】実施の形態3にかかるバッテリー内部抵抗の推定方法について説明する。バッテリーの解放電圧 V_o と端子電圧Vと内部抵抗Rの関係を(1)式に示す。

$$【0022】V_o = V - R \cdot I \dots (1)$$

ここで、短時間と仮定するとバッテリー解放電圧 V_o が変化せず、SOCも変化しないため、この短時間の間に異なる2つの負荷条件時の電圧、電流データを検出すれば、(2)(3)式より(4)式が成立し、(5)式よりバッテリー内部抵抗Rを推定することが可能となる。

*【0023】

$$V_o = V_1 - R \cdot I_1 \dots (2)$$

$$V_o = V_2 - R \cdot I_2 \dots (3)$$

$$(2) - (3) \text{ より } V_1 - V_2 = R \cdot (I_1 - I_2) \dots (4)$$

$$\text{従って、内部抵抗推定値} R \text{ は、} R = (V_1 - V_2) / (I_1 - I_2) \dots (5)$$

ただし、 V_1 、 V_2 はバッテリー端子間電圧で測定値
 I_1 、 I_2 はバッテリーの負荷電流で測定値
実施の形態3によれば、図2の計算フローにおける④のバッテリー内部抵抗Rの推定を(5)式により簡単に行なうことができる。

【0024】実施の形態4

上記図1のSOC推定の演算フローにおける⑤のバッテリー負荷電流I(測定値)は、ホールCTなどで検出している。実施の形態4は、負荷がインバータモータの場合、図1の⑤の負荷電流Iを測定する代りに電圧VDC※50

※(=バッテリー電圧V)(測定値)とモータ回転数 ω (測定値)及びトルク指令Tを用いて演算により負荷電流Iを推定する。

【0025】上記負荷電流I推定の演算処理手順を図4について説明する。予めトルク指令Tとモータ回転数 ω に対するモータ効率とインバータ効率を含んだインバータモータの総合効率 η のマップCを用意しておく。

【0026】図1②のトルク指令Tがゼロか否かの判断結果がNOの場合、51で直流電圧VDC(測定値)、モータ回転数 ω (測定値)及びトルク指令Tを取り込

み、52でインバータモータの総合効率マップCを用いて現時点のモータ回転数 ω とトルク指令から総合効率 η を求め、53で現時点のモータ回転数 ω とトルク指令から導かれるモータ出力 T と総合効率 η からバッテリー出力 $P = \omega T / \eta$ を求め、54でバッテリー出力 P と直流電圧 VDC からバッテリー負荷電流 $I = P / VDC$ を算出する。

【0027】電気自動車やハイブリッド電気自動車等では、モータ回転数を測定している。実施の形態4はこのモータ回転数を利用してバッテリー負荷電流を推定するので、ホールCT等のバッテリー負荷電流検出器が不要となり、コスト的に有利となる。なお、この負荷電流算出方法は図2の⑤にも適用できる。

【0028】実施の形態5

実施の形態5は、実施の形態3の装置において、図2の計算フロー⑤のバッテリー負荷電流 I （測定値）を測定せずに、実施の形態4と同様にバッテリー負荷電流を推定してSOCの推定を行なう。

【0029】即ち、図2の演算フローにおいて、④のバッテリー内部抵抗 R （測定値）を上記(5)式により推定し、⑤のバッテリー負荷電流 I （測定値）を図4に示すように、トルク指令 T とモータ回転数 ω に対するモータ効率とインバータ効率を含んだインバータモータの総合効率マップCからインバータモータの総合効率 η を求めてバッテリー出力 $P = \omega T / \eta$ を求め、バッテリー出力 P と直流電圧 V （測定値）からバッテリー負荷電流 $I = P / VDC$ を推定し、バッテリー端子電圧（測定値）と推定したバッテリー内部抵抗 R 及びバッテリー負荷電流から⑦の解放電圧 $V_o = (1 - W) \cdot V_a + W \cdot V_b$ を求め、⑧で解放電圧 V_o からSOCを計算により推定する。

【0030】上記実施の形態5によれば、バッテリー負荷電流を推定しているのでホールCT等を必要とせず、実

施の形態3に比較してコスト的に有利となる。

【0031】

【発明の効果】この発明は、上述のとおり構成されているので、以下に記載する効果を奏する。

(1) 電圧精度として不十分な負荷運転時のバッテリーの推定解放電圧に対し、電圧精度が高い無負荷運転時の解放電圧を重み付けて計算処理しているので、バッテリーの解放電圧の演算精度が上がり、SOCの推定精度が向上する。

(2) バッテリーの内部抵抗は放電時と充電時についてSOCの関数となっているので、SOC-バッテリー内部抵抗の特性マップを利用しSOCの前回値よりバッテリー内部抵抗を推定した場合SOC推定精度が向上する。

(3) バッテリー解放電圧が変化しないと仮定することができる、短時間の間の異なるバッテリー端子電圧、電流からバッテリー内部抵抗を推定した場合、比較的簡単な演算でバッテリー内部抵抗を推定することができる。

(4) バッテリー負荷電流を推定している場合、ホールCTなどのバッテリー電流検出器を必要としないので、コスト的に有利となる。

【図面の簡単な説明】

【図1】この発明の実施の形態1にかかるSOC推定装置のSOC演算フロー図。

【図2】この発明の実施の形態2にかかるSOC推定装置のSOC演算フロー図。

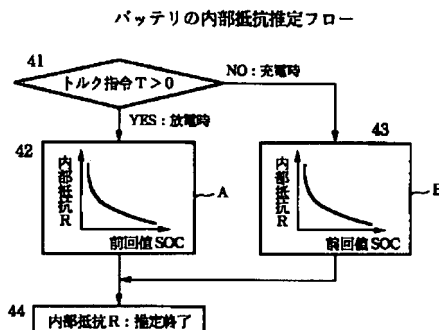
【図3】同装置のバッテリーの内部抵抗推定フロー図。

【図4】この発明の実施の形態4にかかるSOC推定装置のバッテリー負荷電流演算フロー図。

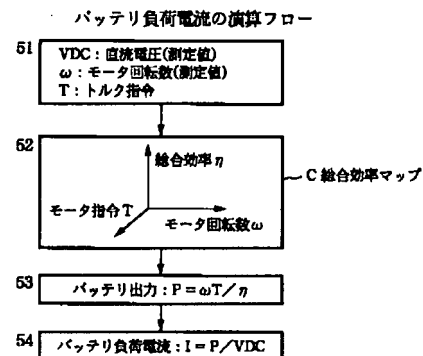
【図5】従来例にかかるSOC推定装置のSOC演算フロー図。

【図6】他の従来例にかかるSOC推定装置を示すブロック図。

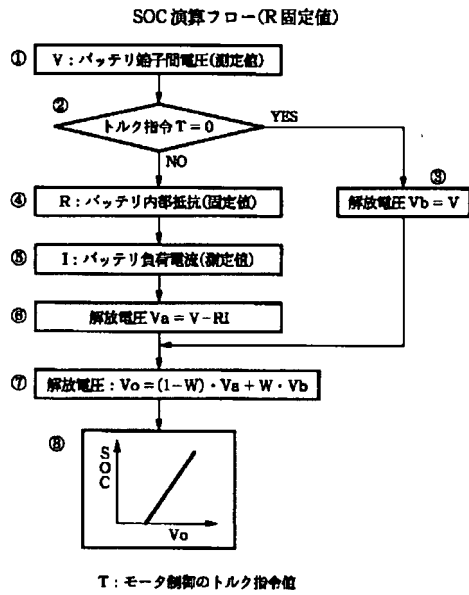
【図3】



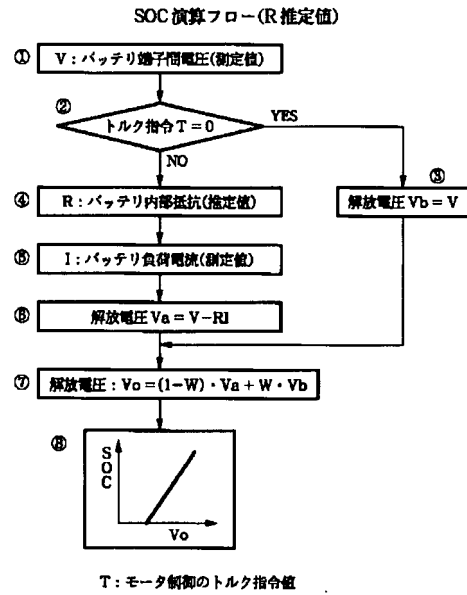
【図4】



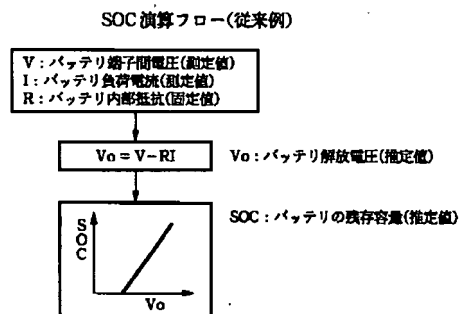
【図1】



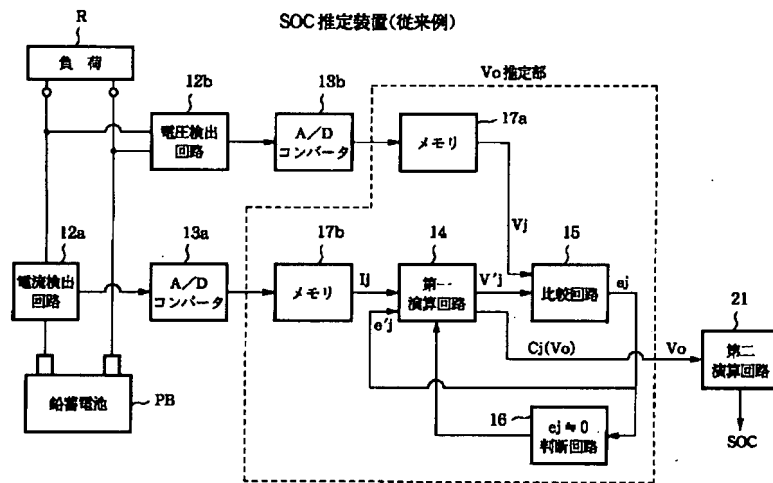
【図2】



【図5】



【図6】



フロントページの続き

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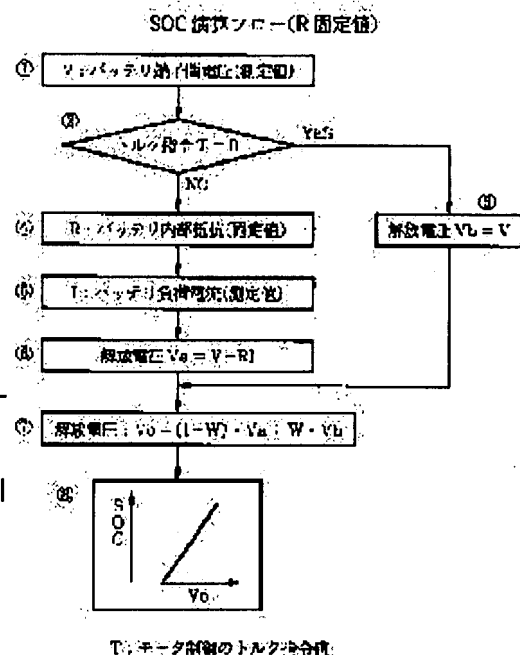
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(54) ESTIMATION DEVICE FOR BATTERY RESIDUAL CAPACITY

(57)Abstract:

PROBLEM TO BE SOLVED: To precisely estimate a battery residual capacity (SOC) by eliminating the computing error of a battery open-circuit voltage.

SOLUTION: A battery interterminal voltage V is measured in (1). The existence of a battery load is judged on the basis of the torque command of a load (a motor) in (2). An open-circuit voltage $V_b = V$ at a time when the load is operated is found in (3). In (6), an open-circuit voltage V_a at a time when the battery load is operated is found as $V_a = V - RI$ on the basis of the internal resistance R , the interterminal voltage V and the load current I of a battery. In (7), the voltage V_a and the voltage V_b are weighted W , and a battery open-circuit voltage $V_o = (1-W) \cdot V_a + W \cdot V_b$ is calculated. In (8), the battery residual capacity SOC is calculated on the basis of the open-circuit voltage V_o so as to be estimated. When the residual capacity SOC is estimated, the open-circuit voltage V_b in a no-load state whose voltage accuracy is high is weighted with reference to the estimated



open-circuit voltage at a time when the load whose voltage accuracy is insufficient is operated, and the battery open-circuit voltage V_o is calculated. As a result, the estimation accuracy of the open-circuit voltage V_o is increased, and the estimation accuracy of the residual capacity SOC is enhanced.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the dc-battery remaining capacity presumption equipment in the system which drives a motor by making dc-batteries, such as an electric vehicle and a hybrid electric vehicle, into an energy source which presumes the remaining capacity of a dc-battery.

[0002]

[Description of the Prior Art] Generally, the remaining capacity (SOC) of a dc-battery has close relation with the release electrical potential difference of a dc-battery, and it is possible to presume SOC from a release electrical potential difference.

[0003] Although the release electrical potential difference of a dc-battery cannot carry out direct presumption at the time of a load, it can compute according to the electrical potential difference between dc-battery terminals, dc-battery internal resistance (fixed value), and the dc-battery load current (discharge current or charging current), and SOC can be presumed from this value. The operation flow of this SOC presumption is shown in drawing 5.

[0004] An example of equipment which presumes a release electrical potential difference from the electrical potential difference under energization and the presumed data of a current, and presumes SOC is shown in drawing 6. This equipment presumes electrical-potential-difference V_j between dc-battery terminals ' in the first arithmetic circuit 14 from the observation current data I_j which detected and carried out A/D conversion of the load current of Dc-battery PB. The difference e_j of the electrical-potential-difference data V_j between observation terminals which detected and carried out A/D conversion of the battery voltage, and above-mentioned electrical-potential-difference V_j between presumed terminals ' is calculated in a comparator circuit 15. Making said difference e_j feed back in order to make electrical-potential-difference V_j between presumed terminals ' approximate to the electrical potential difference between observation terminals in the 1st arithmetic circuit 14 based on said difference e_j , modification and the operation of a function term of the 1st relational expression in the 1st arithmetic circuit 14 are repeated until it is set to $e_j=0$. A part for a constant C_j is outputted as a presumed release electrical potential difference, and SOC is calculated in the second arithmetic circuit 21 based on a presumed release electrical potential difference. (JP,5-142314,A)

[0005]

[Problem(s) to be Solved by the Invention] By the way, since the dc-battery internal resistance R changes serially in relation to the value of SOC, it is difficult the internal

resistance to presume exact SOC. Moreover, in order to presume the load current (discharge current, charging current) from a dc-battery, it is necessary to attach current detection equipments, such as Hole CT, and becomes cost quantity.

[0006] The place which it is made that the above-mentioned technical problem should be solved, and is made into that purpose has this invention in offering the dc-battery remaining capacity presumption equipment which gave weight to the presumed release electrical potential difference at the time of no-load running and load operation in quest of the dc-battery internal resistance based on the value of SOC last time, and raised precision and which enabled it to presume SOC correctly from open circuit voltage.

[0007]

[Means for Solving the Problem] It carries out that set this invention to the dc-battery remaining-capacity presumption equipment which presumes a dc-battery release electrical potential difference from the electrical potential difference between dc-battery terminals, the dc-battery load current, and dc-battery internal resistance, and presumes the remaining capacity of a dc-battery from this presumed dc-battery release electrical potential difference, and it gives and computes weight on the presumed release electrical potential difference at the time of load operation which deducted a part for dc-battery internal-resistance descent from the release electrical potential difference at the time of no-load running of a dc-battery and the terminal voltage at the time of load operation of a dc-battery as the description. [electrical potential difference / said / presumed dc-battery release]

[0008] Said dc-battery internal resistance is good to presume from count using the electrical potential difference between dc-battery terminals and the dc-battery load current at the time before and after the short time which can be assumed that property map **** of dc-battery remaining capacity-internal resistance and this property map are used, and presumption or a dc-battery release electrical potential difference does not change with operations from the last value of dc-battery remaining capacity.

[0009] Moreover, when a dc-battery load is an inverter motor, the overall-efficiency map of an inverter motor including a motor efficiency and inverter effectiveness is prepared, and said dc-battery load current is good to ask for a motor output from the engine speed of the inverter motor which is the load of a dc-battery at present, and a torque command, to ask for dc-battery output power with the effectiveness drawn from the overall-efficiency map of this motor output and said inverter motor, and to presume the dc-battery load current by count from this dc-battery output power and the electrical potential difference between dc-battery terminals.

[0010]

[Embodiment of the Invention] Gestalt 1 electric vehicle and the high Brit electric vehicle of operation usually have plentifully the case where the torque command of a motor is made into zero, at the time of transit. Since a dc-battery current serves as zero when a torque command is zero, a dc-battery release electrical potential difference becomes equal to terminal voltage, and can presume exact dc-battery remaining capacity (SOC).

[0011] The gestalt 1 of operation adds conditions in case a torque command value is zero to the count flow of SOC presumption conventionally shown in drawing 5 , as shown in drawing 1 , it performs weighting further, and presumes SOC. SOC presumption equipment consists of operation part which consists of the electrical potential difference which detects the electrical potential difference between dc-battery terminals, and the dc-

battery load current, a current detector, the detected electrical potential difference and the A/D converter which changes a current signal into a digital signal, a CPU that carries out SOC presumption using this electrical potential difference and current data (illustration abbreviation).

[0012] About drawing 1 , the data-processing procedure of SOC presumption in the above-mentioned SOC presumption equipment operation part is explained.

[0013] First, it judges whether the torque command T of the motor which CPU measures the electrical potential difference V between dc-battery terminals through an A/D converter by step **, and is driven with a dc-battery by ** is zero. When this decision result is YES ($T=0$), the electrical potential difference V between dc-battery terminals is substituted for the release electrical potential difference V_b by **. In NO ($T \neq 0$), the dc-battery internal resistance R (fixed value) and the dc-battery load current I are incorporated by ** and **, and it computes release electrical-potential-difference $V_a = V - RI$ by **.

[0014] ** Compute release electrical-potential-difference $V_o = (1-W)V_a + W V_b$ by making weighting the release electrical potential differences V_a and V_b . It can set it as arbitration whether the release electrical potential difference V_a at the time of load operation by count is thought as important by weight W attachment, or the release electrical potential difference V_b at the time of no-load running is thought as important. (At the time of $W=0$: At $V_o = V_a$, the time of $W=1$ $V_o = V_b$). And SOC is calculated from the release electrical potential difference V_o by **, and SOC is presumed.

[0015] Since according to the gestalt 1 of the above-mentioned implementation conditions in case the torque command T is zero were added to the SOC presumption method of drawing 5 conventionally [above-mentioned], weighting was performed on the release electrical potential difference at the time of a load and no-load and SOC is presumed, the precision of SOC presumption improves.

[0016] It turns out that the gestalt 2 dc-battery internal resistance R of operation is the function of the remaining capacity (SOC) of a dc-battery about each at the time of discharge and charge.

[0017] the dc-battery internal resistance R of ** used for count of the release electrical potential difference V_a of ** of above-mentioned drawing 1 as the gestalt 2 of operation is shown in drawing 2 (fixed value) -- estimate -- replacing with -- ** -- it carries out and SOC is presumed like the case of drawing 1 .

[0018] The data-processing procedure of dc-battery internal resistance R presumption of the above-mentioned drawing 2 ** is explained about drawing 3 . The maps A and B of internal resistance R to SOC are beforehand prepared about each at the time of charge of a dc-battery, and discharge, and when the torque command in ** of drawing 2 is [the decision result of being 0] NO, it judges whether the torque command T is larger than zero at step 41. When this decision result is YES (at the time of discharge), the dc-battery internal resistance R is presumed from a presumed SOC value last time on Map A by 42, and, in NO (at the time of charge), the dc-battery internal resistance R is presumed from a presumed SOC value last time on Map B by 43.

[0019] Since the release electrical potential difference V_a is calculated by having presumed the dc-battery internal resistance R according to the gestalt 2 of the above-mentioned implementation, it improves from the case where the presumed precision of SOC is above-mentioned drawing 1 .

[0020] Although SOC is presumed by the count flow of SOC presumption of drawing 2 like the gestalt 2 of operation with the gestalt 3 of gestalt 3 implementation of operation, presumption of the dc-battery internal resistance R of ** is presumed by count using the electrical potential difference V between terminals and the load current I of a dc-battery.
[0021] The presumed approach of the dc-battery internal resistance concerning the gestalt 3 of operation is explained. The relation of the release electrical potential difference V_o , the terminal voltage V, and internal resistance R of a dc-battery is shown in (1) type.

[0022] $V_o = V = R \cdot I$ -- (1)

If it assumes that it is a short time and the electrical potential difference at the time of two different load conditions between this short time and current data will be detected here since the dc-battery release electrical potential difference V_o does not change and SOC does not change, either, (4) types will be materialized and it will become more possible than (5) types from (2) and (3) type to presume the dc-battery internal resistance R.

[0023]

$V_o = V_1 - R \cdot I_1$ -- (2)

$V_o = V_2 - R \cdot I_2$ -- (3)

(2) - (3) $V_1 - V_2 = R \cdot (I_1 - I_2)$ -- (4)

Therefore, the internal resistance estimate R is $R = (V_1 - V_2) / (I_1 - I_2)$. -- (5)

However, according to the gestalt 3 of the measured-value operation by the load current of a dc-battery in measured value I_1 and I_2 , V_1 and V_2 can presume dc-battery internal resistance R of ** in the count flow of drawing 2 easily by (5) types on the electrical potential difference between dc-battery terminals.

[0024] The dc-battery load current I of ** in the operation flow of SOC presumption of gestalt 4 above-mentioned drawing 1 of operation (measured value) is detected in Hole CT etc. When a load is an inverter motor, instead of measuring the load current I of ** of drawing 1, an electrical potential difference VDC (= battery voltage V) (measured value), the motor rotational frequency ω (measured value), and the torque command T are used for the gestalt 4 of operation, and it presumes the load current I by the operation.

[0025] The data-processing procedure of the above-mentioned load current I presumption is explained about drawing 4. The map C of the overall efficiency η of the inverter motor which included the torque command T, the motor efficiency to the motor engine speed ω , and inverter effectiveness beforehand is prepared.

[0026] When the torque command T of drawing 1 ** is NO, the decision result of being zero by 51 Direct current voltage VDC (measured value) Incorporate the motor engine speed ω (measured value) and the torque command T, and overall efficiency η is searched for from the motor engine speed ω at present and a torque command using the overall-efficiency map C of an inverter motor by 52. It asks for dc-battery output $P = \omega \cdot T / \eta$ from the motor engine speed ω at present by 53, motor output $\omega \cdot T$ drawn from a torque command, and overall efficiency η , and dc-battery load current $I = P / VDC$ is computed from the dc-battery output P and direct current voltage VDC by 54.

[0027] The motor rotational frequency is measured in the electric vehicle or the hybrid electric vehicle. Since the gestalt 4 of operation presumes the dc-battery load current using this motor engine speed, dc-battery load current detectors, such as Hole CT, become unnecessary, and it becomes advantageous in cost. In addition, this load current

calculation approach is applicable also to ** of drawing 2 .

[0028] In the equipment of the gestalt 3 of operation, without measuring the dc-battery load current I of count flow ** of drawing 2 (measured value), the gestalt 5 of gestalt 5 implementation of operation presumes the dc-battery load current as well as the gestalt 4 of operation, and presumes SOC.

[0029] Namely, as the dc-battery internal resistance R of ** (measured value) is presumed by the above-mentioned (5) formula and is shown in drawing 4 in the operation flow of drawing 2 , the dc-battery load current I of ** (measured value) In quest of the overall efficiency η of an inverter motor, it asks for dc-battery output $P = \omega T / \eta$ from the overall-efficiency map C of an inverter motor including the torque command T, the motor efficiency to the motor engine speed ω , and inverter effectiveness. Dc-battery load current $I = P / V_{DC}$ is presumed from the dc-battery output P and direct current voltage V (measured value). Release electrical-potential-difference $V_o = (1 - W)$ and $V_a + W - V_b$ of ** are calculated from the dc-battery internal resistance R presumed to be dc-battery terminal voltage (measured value) and the dc-battery load current, and SOC is presumed by count from the release electrical potential difference V_o by **.

[0030] According to the gestalt 5 of the above-mentioned implementation, since the dc-battery load current is presumed, Hole CT etc. is not needed, but as compared with the gestalt 3 of operation, it becomes advantageous in cost.

[0031]

[Effect of the Invention] Since this invention is constituted as above-mentioned, it does so the effectiveness indicated below.

(1) Since computation of the release electrical potential difference at the time of no-load running with a high electrical-potential-difference precision is carried out by weighting to the presumed release electrical potential difference of the dc-battery at the time of load operation inadequate as an electrical-potential-difference precision, the operation precision of the release electrical potential difference of a dc-battery goes up, and the presumed precision of SOC improves.

(2) Since the internal resistance of a dc-battery serves as a function of SOC about the time of discharge and charge, when the property map of SOC-dc-battery internal resistance is used and dc-battery internal resistance is presumed from the last value of SOC, SOC presumption precision improves.

(3) When dc-battery internal resistance is presumed from the dc-battery terminal voltage from which it differs between the short time which can be assumed that a dc-battery release electrical potential difference does not change, and a current, dc-battery internal resistance can be presumed by the comparatively easy operation.

(4) Since dc-battery current detectors, such as Hole CT, are not needed when the dc-battery load current is presumed, it becomes advantageous in cost.

[Translation done.]

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CLAIMS

[Claim(s)]

[Claim 1] The dc-battery remaining-capacity presumption equipment characterized by to set to the dc-battery remaining-capacity presumption equipment which presumes a dc-battery release electrical potential difference from the electrical potential difference between dc-battery terminals, the dc-battery load current, and dc-battery internal resistance, and presumes the remaining capacity of a dc-battery from this presumed dc-battery release electrical potential difference, and to give and compute weight on the presumed release electrical potential difference at the time of load operation which deducted a part for dc-battery internal-resistance descent from the release electrical potential difference at the time of no-load running of a dc-battery and the terminal voltage at the time of load operation of a dc-battery. [electrical potential difference / said / presumed dc-battery release]

[Claim 2] Dc-battery remaining capacity presumption equipment characterized by preparing a dc-battery remaining capacity-internal resistance property map, using said dc-battery internal resistance and presuming the property map of dc-battery remaining capacity-internal resistance for it in data processing from the last value of dc-battery remaining capacity in claim 1.

[Claim 3] Dc-battery remaining capacity presumption equipment characterized by what is presumed in data processing from the different electrical potential difference between dc-battery terminals and the different dc-battery load current between the short time which can assume said dc-battery internal resistance that a dc-battery release electrical potential difference does not change in claim 1.

[Claim 4] The dc-battery remaining-capacity presumption equipment characterized by to prepare the overall-efficiency map of an inverter motor including a motor efficiency and inverter effectiveness when a dc-battery load is an inverter motor in claim 1 or 3, to ask for a motor output from the engine speed of the inverter motor which is the load of a dc-battery about said dc-battery load current at present, and a torque command, to ask for dc-battery output power with the effectiveness drawn from the overall-efficiency map of this motor output and said inverter motor, and to compute the dc-battery load current from this dc-battery output power and the electrical potential difference between dc-battery terminals.

[Translation done.]